CONSERVATION AND PROTECTION

ENVIRONMENT CANADA

RESULTS MEASUREMENT PROJECT REPORT

October 1989

TABLE OF CONTENTS

INDEX

1. I. EXECUTIVE SUMMARY

2. II. INTRODUCTION

3. III. RESULTS MEASUREMENT

4. IV. RESULTS MODEL

5. V. MEASURES AND THE MODEL

6. VI. IMPLEMENTATION

7. VII. USE

8. - **APPENDIX A** - FULL SET OF RESULTS MEASURES FOR THE C&P RESULTS MODEL

- **APPENDIX B** - PROPOSED C&P MANAGEMENT INFORMATION COMMITTEE/TERMS OF REFERENCE

- **APPENDIX C** - A FRAMEWORK FOR MEASURING COMMUNICATION RESULTS

- **APPENDIX D** - EXCERPT FROM OCG DOCUMENT: EVALUATION OF RESEARCH & DEVELOPMENT PROGRAMS

I. EXECUTIVE SUMMARY

1- A total of 75 results measurements have been identified as deserving of consideration for implementation by Conservation and Protection. These measures were selected from a much larger list assembled by the Results Measurement Working Group from a variety of sources. The 75 result measurements, to the greatest extent possible, measure and address directly the Effect statements of the C&P Results Model. There are at least one, sometimes two, key measure per Effect.

The 75 measurements have been classified as follows:

CLASSIFICATION	DESCRIPTION		NO. OF MEASURES
A*	Could be implemented immediately with little or no additional costs and are a key measure.	=	26
A	Could be implemented immediately with little or no additional costs.	=	6
B_1	Require some development work and could be implemented within approximately one year.	=	17
B_2	Require considerable development and are unlikely to be implemented for at least two years.	=	26
		TOTAL	75

(See Appendix A for full list and description)

RECOMMENDATION 1: **That implementation of C&P result measures be phased in over a three year period beginning April 1, 1990, commencing with implementation of A* measures.**

2- Development and fine tuning of results measures will be an ongoing and iterative process, as will the collection and interpretation of result measurement information.

RECOMMENDATION 2: **That MIAB be assigned responsibility for collection of results measurement information and be supported by a committee of regional and headquarters Planning Officers.**

3- Result measures provide senior managers with information pertaining to the achievement of desired results. Result measures should be used as a red flag mechanism to identify areas of potential weakness in program delivery or in the strategies selected to deliver a program. This type of review of C&P programs by senior management can best be done as part of the annual strategic planning process, as it will lead to the modification of programs and strategies, or to the re evaluation of the effects desired.

RECOMMENDATION 3: **That the results measurement information be collected, interpreted and assembled into an annual national report for review by the ADM and C&P Management Board.**

4- The department is at present in the process of negotiating its Operational Planning Framework (OPF), in the context of the Increased Ministerial Authority and Accountability (IMAA) Memorandum of Understanding with Treasury Board. Reporting on results is a principle central to the IMAA Regime.

Treasury Board was impressed by the results orientation approach adopted by C&P in its OPF development efforts, and expressed particular interest in results measures at the environmental improvement level.

RECOMMENDATION 4: **That A* measures at the Environmental Improvement level be provided to Corporate Planning Group to satisfy Treasury Board requirements related to the OPF and IMAA processes.**

II. INTRODUCTION

- In November 1987, the Assistant Deputy Minister, Conservation and Protection (C&P) initiated the development of a result definition model for C&P. As a graphic presentation of an organization's mission, client needs, and expected results, a results model was desired for several reasons. First, the fall 1987 C&P National Management Conference had recognized that a results model would be a useful tool for enhancing C&P communications, both internally and externally. Second, opportunities to use the results model to improve the C&P planning and review process were also evident. In particular, the DOE Operational Planning Framework (OPF) was viewed to be an inadequate basis for national program planning and reporting. The C&P portion of the DOE OPF was an interim structure, dating from the 1986 consolidation of the Environmental Conservation and Environmental Protection Services into Conservation and Protection. The new C&P results model provided an opportunity to integrate the planning structures of the various component organisations, while at the same time responding to Treasury Board's requirement for a results - oriented OPF as part of its Increased Ministerial Authority and Accountability (IMAA) exercise.

- The C&P Results Model was submitted to Management Board on 30 June 1988 and approved for implementation in the 1989/90 planning cycle. At the same time Management Board directed that an action plan be formulated for the development of Results Measures. The action plan was approved by Management Board in October 1988.

- This report describes the Results Measures that have been developed to correspond with the Effect statements contained within the C&P Results Model. Recommendations are provided for the implementation of the measures, with specific reference to a staged phase in over a three year period. Use of results measurement as a management tool, a mechanism for reporting to Central Agencies, and for communicating to external agencies and the public, is discussed.

- It is important to recognize that the results measures presented in this report are the culmination of an extensive consultative process with C&P managers and staff at all levels and in all regions of Canada. Without the full and ongoing commitment of these contributors, this work would not have been possible.

- A key element of the process was the direction of a Steering Committee of Senior C&P managers. This group was accountable for guiding development of the results measures, and provided a critical link with C&P Management Board. The Steering Committee had both headquarters and regional representation as well as representatives from both line and staff management. Reporting to the Steering Committee was a Working Group, which also included representation from all regions and all headquarters directorates.

III. RESULTS MEASUREMENT

° Since its inception, the C&P Results Model has been put to a variety of uses. It has become the basis for a revised Operational Planning Framework. It provides the framework for C&P Operational Planning and Work Planning, and for the allocation and reporting of resources. The Results Model's origins, however, are as a program evaluation tool. A primary purpose of the model is to facilitate assessment of the "effects" of activities. Results measures are the means by which we measure these effects. The measurement of actual effects achieved and comparison against the desired effects articulated within the model is the basis of evaluating the success of a program in meeting its objectives.

THE IDEAL MEASURE

1. Provides an agreed basis for decision making. One purpose of measurement is to provide factual assistance for decision-making by diverse human minds. The greater the validity of the measurement concept, the greater is the likelihood of securing a meeting of those minds.

2. Is understandable. Any vagueness or complexity becomes a natural source of divisiveness. Those who lack understanding of the unit of measure become suspicious of those who possess that understanding.

3. Applies broadly. Measures of quality features are widely used as a basis for comparative analysis. Whether at the technological level or the managerial level, we need to answer such questions as: Is our quality getting better or worse? Units of measure that have broad applicability can help answer such questions.

4. Is susceptible to uniform interpretation. Identical numbers can nevertheless result in widely different interpretations. What is critical is whether the units of measure have been defined with adequate precision.

5. Is economic to apply. It is obvious that a balance must be struck between the cost of making evaluations and the value of having them.

6. Is compatible with existing designs of sensors. Measurement of quality is wonderfully simple if a ready-made instrument exists, one that we can plug in to and read the result in terms of the unit of measure.

IV. RESULTS MODEL

THE MODEL

There are four basic components to the C&P Results Model. These are the statements of Mission, Needs, Effects and Activities. The **Mission** is a broad statement of the scope and authority of the organization. The **Needs** are statements of public expectations; these are conditions which must be satisfied if the organization is to be successful. **Effects** are the benefits or results which will accrue from program activities, and **Activities** are descriptions of what the organization actually does to achieve its intended results.

Results measures are linked to the Effects of the model. Results measures are designed to correspond directly to the desired results as articulated in the Effect statements. Weaknesses in the articulation of desired results will therefore be passed along to the result measurements. In using the C&P Results Model to develop result measures the Working Group identified a small number of apparent weaknesses in the model. In particular the articulation of results concerning water programs and the support functions is not well developed, and should be reviewed.

EFFECTS

There are two types of results defined at the Effects level of the C&P Result Model. The first type describes the Environmental Improvements expected to be achieved by C&P Programs. The second type is strategic, in that it focuses on how C&P approaches the resolution of particular environmental issues. The strategic effects separate the approaches of C&P into four components. These are:

1. Science/Data, which includes all strategies devoted to the development of environmental knowledge (e.g., research, data collection);

2. Communication, which incorporates the results expected from communicating environmental knowledge to potential users of that knowledge;

3. Influence/Leadership, which emphasizes that C&P's role is often limited to trying to get others to act "responsibly" with respect to environmental problems;

4. Enforcement/Compliance, which includes all results expected from the application of regulations inherent in environmental conservation/protection legislation.

Results measures have been developed which address each level of effect. At the Environmental Improvement, Enforcement/Compliance, and Influence/Leadership levels specific measures have been identified for each program. At the Communications and Science/Data levels, generic measures are recommended for use across the model.

(For a more thorough discussion of the C&P Results Model the reader is referred to "Results Model/Operational Planning Framework Project Report", C&P, June 1988)

CONSERVATION AND [illegible]N AND PROTECTION

MARCH 1988

[illegible]SSION

NEEDS

CONTRIBUTE TO THE CONSERVATION AND PROTECTION OF THE CANADIAN AND GLOBAL ENVIRONMENTS FOR SUSTAINED BENEFITS

A CONSERVE CANADA'S NATURAL RESOURCES

B MANAGE ECOLOGICAL AND ECONOMIC INTERDEPENDENCE

C PROTECT CANADA'S ENVIRONMENT FROM DEGRADATION

FECTS
vironmental
provements

- A1 MIGRATORY BIRD POPULATIONS ARE SUSTAINED OR INCREASED
- A7 WILDLIFE HABITAT IS MAINTAINED OR ENHANCED
- A13 ENDANGERED SPECIES ARE REESTABLISHED AND REHABILITATED
- A18 CANADA'S ACCESS (QUALITY/QUANTITY) TO INTERNATIONAL WATER AND WILDLIFE RESOURCES IS MAINTAINED OR ENHANCED
- A24 REGIONAL ACCESS TO GOOD QUALITY WATER AND WILDLIFE RESOURCES IS MAINTAINED OR IMPROVED
- A29 DAMAGES RESULTING FROM NATURAL HAZARDS ARE REDUCED
- A39 DAMAGES RESULTING FROM NATURAL HAZARDS ARE REDUCED
- B1 CONSERVATION, DEVELOPMENT AND PROTECTION EFFORTS COMBINE TO PRODUCE A HEALTHY CANADIAN ECOSYSTEM AND ECONOMY
- C1 ADVERSE ENVIRONMENTAL IMPACTS OF NEW INITIATIVES ARE REDUCED
- C6 IMPACTS OF HARMFUL AIR & WATER EMISSIONS/EFFLUENTS ARE REDUCED
- C12 HARMFUL IMPACTS OF TOXICS AND OTHER PRODUCTS ARE CONTROLLED
- C17 ENVIRONMENTAL QUALITY AT SPILL AND WASTE SITES IS RESTORED TO ACCEPTABLE LEVELS

Enforcement / Compliance

- A2 CANADIANS COMPLY WITH LEGISLATION AFFECTING MIGRATORY BIRD MANAGEMENT
- A8 FEDERAL, PROVINCIAL AND PRIVATE LAND MANAGERS COMPLY WITH LEGISLATION TO PROTECT WILDLIFE HABITAT
- A14 WILDLIFE MANAGERS AND CANADIANS COMPLY WITH LEGISLATION TO PROTECT ENDANGERED SPECIES
- A19 LAND MANAGERS COMPLY WITH LEGISLATION RELATED TO CHANGES TO CANADA-U.S. RIVER SYSTEMS
- C7 POLLUTERS COMPLY WITH LEGISLATION RELATED TO EMISSIONS AND EFFLUENTS
- C13 USERS COMPLY WITH LEGISLATION ON THE INTRODUCTION, USE, TRANSPORTATION AND DISPOSAL OF TOXICS AND OTHER PRODUCTS
- C18 POLLUTERS COMPLY WITH LEGISLATION ON THE CLEAN-UP OF SPILL/WASTE SITES

fluence / Leadership

- A3 CANADIANS IMPLEMENT CO-OPERATIVE PROGRAMS WITH C&P TO INCREASE ENJOYMENT OF MIGRATORY BIRDS
- A9 CANADIANS ACTIVELY SUPPORT WILDLIFE HABITAT MANAGEMENT, ENHANCEMENT AND MAINTENANCE
- A15 PROGRAMS ARE IN PLACE TO PROTECT/REHABILITATE ENDANGERED SPECIES IN COOPERATION WITH OTHER STAKEHOLDERS
- A20 EXTERNAL AFFAIRS, IJC & OTHER INTERNATIONAL FORA INCORPORATE C&P ADVICE ON WATER/WILDLIFE
- A25 AGREEMENTS ON THE MANAGEMENT OF SHARED (INTER-PROVINCIAL, TERRITORIAL) WATER AND WILDLIFE RESOURCES ARE IN PLACE
- A30 FLOOD PLAIN RESIDENTS ARE PROTECTED FROM MAJOR FLOODING EVENTS
- A30 FLOOD PLAIN RESIDENTS ARE PROTECTED FROM MAJOR FLOODING EVENTS
- B2 C&P PROGRAMS ARE MANAGED EFFECTIVELY & EFFICIENTLY
- B5 ENVIRONMENTAL AND RESOURCE VALUE/ PRICING CONSIDERATIONS ARE INTEGRATED INTO ECONOMIC PLANNING AND DECISION MAKING
- C2 PROPONENTS INCORPORATE C&P ADVICE INTO DEVELOPMENT INITIATIVES
- C8 ENVIRONMENTAL QUALITY OBJECTIVES OR GUIDELINES ARE DEVELOPED AND IMPLEMENTED
- C14 CODES/GUIDELINES FOR LIFECYCLE MANAGEMENT OF CHEMICALS ARE DEVELOPED AND IMPLEMENTED
- C19 CONTINGENCY PLANS AND OTHER MECHANISMS EXIST FOR DEALING WITH ENVIRONMENTAL POLLUTION EMERGENCIES

- A4 PROVINCES/USA ACCEPT HARVEST LIMITS FOR GAME BIRDS
- A10 LAND MANAGERS INCORPORATE WILDLIFE HABITAT CONCERNS INTO THEIR LAND AND AQUATIC ENVIRONMENTAL MANAGEMENT PRACTICES
- A21 AGREEMENTS FOR THE MANAGEMENT OF CANADA-INTERNATIONAL WATER/WILDLIFE RESOURCES ARE IN PLACE
- A26 WATER AND WILDLIFE MANAGEMENT PLANS FOR MAJOR DRAINAGE BASINS AND REGIONS ARE IN PLACE
- A31 LAND MANAGERS IMPLEMENT LAND USE PRACTICES DESIGNED TO REDUCE DAMAGES CAUSED BY FLOODS AND MIGRATORY BIRDS
- A31 LAND MANAGERS IMPLEMENT LAND USE PRACTICES DESIGNED TO REDUCE DAMAGES CAUSED BY FLOODS AND MIGRATORY BIRDS
- B3 C&P PROGRAMS AND POLICIES ARE DEVELOPED TO RESPOND TO NEW ENVIRONMENTAL ISSUES AND OPPORTUNITIES
- B6 C&P ENVIRONMENTAL SCIENCE/RESEARCH IS INTERNATIONALLY RECOGNIZED

Communications

- A5 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON THE STATUS, TRENDS AND BEHAVIOUR OF MIGRATORY BIRD POPULATIONS
- A11 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON THE LOCATION, DYNAMICS AND SIGNIFICANCE OF WILDLIFE HABITAT
- A16 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON THE STATUS & TRENDS OF ENDANGERED SPECIES POPULATIONS
- A22 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON THE NATURE AND EXTENT OF CANADA-INTERNATIONAL WATER AND WILDLIFE ISSUES
- A27 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON THE NATURE AND EXTENT OF REGIONAL WATER AND WILDLIFE ISSUES
- A32 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON FLOOD RISK AREAS AND ON IMPENDING FLOOD EMERGENCIES
- A32 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON FLOOD RISK AREAS AND ON IMPENDING FLOOD EMERGENCIES
- B4 CANADIANS RECEIVE EARLY WARNINGS & ISSUE SENSING ON EMERGING CONSERVATION/ PROTECTION ISSUES
- B7 CANADIANS ARE PROVIDED INTEGRATED INFORMATION ON THE STATE OF CANADA'S ENVIRONMENT
- C3 CANADIANS RECEIVE AND UNDERSTAND C&P ADVICE ON ENVIRONMENTAL ASSESSMENT
- C9 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON IDENTIFIED POLLUTANT LEVELS, TRENDS, PATHWAYS, TECHNOLOGIES, AND IMPACTS ON AIR, WATER, WILDLIFE AND LAND
- C15 CANADIANS RECEIVE AND UNDERSTAND INFORMATION ON THE LIFECYCLE OF CHEMICALS IN COMMERCE AND THEIR IMPACTS ON AIR, WATER, WILDLIFE AND LAND
- C20 CANADIANS RECEIVE AND UNDERSTAND INFORMATION AND ADVICE ON HAZARDOUS WASTE AND SPILL SITE CLEANUP

Science / Data

- A6 SCIENTIFIC KNOWLEDGE ON THE STATUS, TRENDS, BEHAVIOUR OF MIGRATORY BIRD POPULATIONS IS INCREASED
- A12 SCIENTIFIC KNOWLEDGE ON THE LOCATION, DYNAMICS AND SIGNIFICANCE OF WILDLIFE HABITAT IS INCREASED
- A17 SCIENTIFIC KNOWLEDGE ON THE STATUS AND TRENDS OF ENDANGERED SPECIES IS INCREASED
- A23 SCIENTIFIC KNOWLEDGE AND EXPERTISE ON INTERNATIONAL WATER AND WILDLIFE ISSUES IS INCREASED
- A28 SCIENTIFIC KNOWLEDGE ON THE NATURE AND EXTENT OF REGIONAL WATER AND WILDLIFE ISSUES IS INCREASED
- A33 SCIENTIFIC KNOWLEDGE ON THE NATURE AND EXTENT OF NATURAL HAZARDS AND THEIR ECONOMIC IMPACTS IS INCREASED
- A33 SCIENTIFIC KNOWLEDGE ON THE NATURE AND EXTENT OF NATURAL HAZARDS AND THEIR ECONOMIC IMPACTS IS INCREASED
- B8 INTEGRATED SCIENTIFIC KNOWLEDGE ON THE POLLUTION, USE, VALUE AND STATUS OF THE CANADIAN ECOSYSTEM IS INCREASED
- C4 GUIDELINES FOR ENVIRONMENTAL ASSESSMENT ARE DEVELOPED
- C5 BASELINE KNOWLEDGE TO FACILITATE IMPACT ASSESSMENT IS INCREASED
- C10 SCIENTIFIC KNOWLEDGE ON IMPACTS OF EMISSIONS/EFFLUENTS ON AIR, WATER, WILDLIFE AND LAND IS INCREASED
- C11 NEW POLLUTION CONTROL TECHNOLOGY AND EXPERTISE IS DEVELOPED
- C16 SCIENTIFIC KNOWLEDGE RELATED TO LIFE CYCLE MANAGEMENT OF TOXICS AND THEIR IMPACTS IS INCREASED
- C21 CONTROL TECHNOLOGIES FOR CLEAN-UP ARE DEVELOPED

ACTIVITIES

- MIGRATORY BIRDS MANAGEMENT
- HABITAT MANAGEMENT
- OTHER WILDLIFE MANAGEMENT
- WETLANDS MANAGEMENT
- CROP LOSS MANAGEMENT
- FLOOD DAMAGE REDUCTION
- PROTECTION OF INTERNATIONAL WATER AND WILDLIFE INTERESTS
- WATER QUALITY AND SUPPLY MANAGEMENT
- ENDANGERED SPECIES
- DATA AND RESEARCH

- STATE OF THE ENVIRONMENT
- ENVIRONMENT AND ECONOMY
- NEW PROGRAM AND POLICY DEVELOPMENT
- PROVISION OF FINANCE, ADMINISTRATION, PLANNING, PERSONNEL SERVICES
- EARLY WARNING OF ENVIRONMENTAL ISSUES

- ACID RAIN
- LEAD
- TOXICS
- PESTICIDES
- TOXIC RAIN
- EMERGENCIES
- CLEAN-UP
- CEPA, ECA
- ENVIRONMENTAL QUALITY OBJECTIVES
- CODES OF PRACTICE

V. MEASURES AND THE MODEL

- There are eleven Environmental Improvement level Effects identified on the C&P Results Model. Results measures for effects at this level on the model are aimed at assessing improvements in environmental quality, which ultimately is the desired effect of each C&P program. "State of the Environment" type information provides an indication of overall effectiveness at this level.

- A negative trend in a result measure at the Environmental Improvement level may be due to a factor clearly beyond C&P's realm of influence. C&P has only limited accountability for results at the Environmental Improvements level. A negative trend may also indicate a weakness in C&P program delivery, or in the strategies selected by C&P to achieve the desired results. Results measurement data alone does not provide the full story. It does however serve as a useful "red flag" mechanism.

- In the event that result measurement data does set off a red flag indicating a need for further evaluation of program delivery and strategies, the result measures at the strategic effects levels may provide additional information allowing the evaluation to be focused on a particular component of C&P's activities.

- Appendix A contains a full list of the results measures developed for the C&P Results Model. In the following discussion, Program 1.1, Migratory Birds, is used as an example of the types of measures selected.

Program 1.1
Migratory Birds

EFFECT	MEASURE
° Environmental Improvement: **Migratory Bird Populations are Sustained or Increased**	. Trend in population of mallards in prairie Canada. Trend in selected populations of black ducks in Eastern Canada.
° Enforcement/Compliance: **Canadians comply with legislation affecting migratory bird management**	. Infractions as a percent of total inspections for selected regions (e.g., hunting without permit, hunting out of season).
° Influence/Leadership: **Canadians implement cooperative programs with C&P to increase enjoyment of migratory birds**	. Trend in expenditure of other government agencies and environmental groups on migratory bird-related activities carried out in cooperation with DOE (CWS)
° Influence: **Province/USA accept harvest limits for game birds**	. Trend in percentage of annual hunting regulations guidelines accepted or agreed to by each province; and percentage of recommendations on annual hunting regulations impemented by U.S.
° Communications: **GENERIC**	. Survey of public and special interests to determine awareness, understanding, attitude and behavioural change.
° Science/Data: **GENERIC**	. Self assessment relative to knowledge and expertise of the C&P science mission.

- At the Environmental Improvement level the results measures for Program 1.1 involve trends for key migratory bird populations. Obviously, it is not possible to report on all populations. RESULTS MEASURES ARE SELECTIVE -- OFTEN PROXY MEASURES ARE EMPLOYED.

- A negative trend in a population may be due to a factor such as climatic variation, well beyond the control of C&P. Interpretation accompanying quantitative measures will be critical in identifying such influences. RESULTS MEASURES MUST BE SUPPORTED BY EXPERT INTERPRETATION.

- At the Enforcement/Compliance level, the results measures are related primarily to trends in compliance with C&P regulations. Collection and reporting of such information as the number of inspections conducted, warnings issued and successful prosecutions is also recommended. In some instances compliance data is not presently collected in a usable form, and may be costly to compile. With increasing emphasis on the role of C&P in the enforcement/compliance field, this management information is likely to increase in importance and therefore may well justify the cost of its collection. MOST RESULT MEASURES ARE LOW COST; SOME WILL REQUIRE ADDITIONAL RESOURCES TO IMPLEMENT.

- At the Influence/Leadership level of the model the variety of activities undertaken by C&P is large. Results measures were selected to correspond to key elements of the influence strategy. For Program 1.1 the results measures focus on the trend in external agency expenditures on migratory bird related activities, and on the trend in acceptance of hunting regulations and guidelines by other jurisdictions. RESULTS MEASURES FOCUS ON KEY PROGRAM ELEMENTS.

- The majority of results measures at the Environmental Improvement, Enforcement/Compliance, and Influence/Leadership levels are structured in terms of trends over time. Quantitative measures, in order to be useful, must be displayed against some form of yardstick, either as a percentage of a whole, or in comparison to past achievements. In cases where C&P has established specific objectives, these too are useful to include. Trends, especially at the Environmental Improvement level, may only be discernible over the long term. An effort should therefore be made to compile historic data where available. USEFULNESS OF MEASURES EMPLOYING TREND DATA WILL INCREASE OVER TIME.

- At the Communications level, and at the Science/Data level, generic measures are recommended for use across the model.

- At the Communications level, polling of specific audiences is recommended as the most efficient means of measuring results. A series of questions can be used to measure the effectiveness of a communications effort in terms of achievement of the objectives set out in specific communications plans. Due to the cost of polling, implementation of this measure would have to be selective, and related to key C&P activities.

  Communications objectives may focus on Awareness, Concern, Attitudes, Perceptions, Knowledge, Understanding, Consensus or Behaviour. Typical result measures may therefore include an assessment of:

  - Levels of awareness among target audiences before and after the communications;

  - Changes in strength of concerns, attitudes and perceptions of issues and actors;

  - Extent to which knowledge/understanding was successfully transferred;

  - Ability to produce a formal consensus statement at the end of a consultation process;

  - Changes in levels of self-reported behaviour.

  A more complete discussion of result measurement at the Communication level is contained in Appendix B. Specific measures have been identified for a select number of current communications plans.

- At the Science/Data level of the model it is recommended that results measurement take the form of a periodic report detailing the findings of an objective self assessment of R&D and Data results.

The assessment would be conducted relative to the knowledge and expertise needs of the C&P science mission, and span the spectrum of C&P programs. It would be conducted by individual responsibility centres, using outside peer review as appropriate. Review criteria would be developed to fit each responsibility centre. The Environment Canada Science Committee could be used to review criteria to ensure objectivity and compatibility between responsibility centres. Review Criteria are to be modelled on the criteria drafted by the Comptroller General and outlined in "Evaluation of Research and Development Programs", March 1986. An excerpt from the Comptroller General report dealing with evaluation issues for mission oriented R&D programs, is contained in Appendix C. To spread the costs of this exercise it is recommended that C&P establish a five year cycle in which one fifth of the Science and Data activities are reviewed annually.

VI. IMPLEMENTATION

- A total of 75 results measures have been identified as deserving of consideration for implementation. These measures were selected from a much larger list assembled by the Working Group from a variety of sources. The 75 measures, to the greatest extend possible, meet Juran's criteria for an "ideal measure", and address directly the Effect statements of the C&P Results Model.

- Of the 75 measures only 32 are in a state which would allow immediate implementation. These are class A measures. Of these, 26 are labelled A*. There is at least one (sometimes two) key measure per effect statement. A further 17 measures classed as B_1 require limited development work and could be implemented within approximately one year's time. The remaining 26 measures require considerable development; these are class B_2 measures and are unlikely to be implementable for at least two years.

- The state of the 75 result measures lends itself to a staged implementation of results measurement within C&P. A staged implementation would also permit C&P managers to become gradually familiar with the process of results measurement and thereby allay any remaining fears regarding the resource requirements of the process and the use of the results information collected.

- Implementation of results measures is suggested along the lines of the following schedule:

  - April 1, 1990 - begin implementation of all A* measures.

  - April 1, 1991 - begin implementation of all A and B_1 measures.

  - April 1, 1992 - begin implementation of all B_2 measures.

The A* measures make use of readily available information and involve minimal incremental cost to implement. Other measures require additional development work, and therefore cost estimates have not been finalized. It is suggested that final approval of A, B_1 and B_2 measures by Management Board be deferred until development work has been completed.

RECOMMENDATION 1: That implementation of C&P result measures be phased in over a three year period beginning April 1, 1990, commencing with implementation of A* measures.

A detailed description of the measures and the rationale for their classification is contained in Volume II, Results Measurement Feasibility Analysis.

The development work required for B_1 and B_2 measures is primarily of two types:

- Type one development work involves the fine tuning of measures and information sources. The B_1 result measure for Effect B-5 of the Model, for example, requires that sources of information pertaining to municipal waste generation be defined, and that an appropriate sample size can be determmined.

B-5	MEASURE
Environmental and resource value/pricing considerations are integrated into economic planning and decision making	Trend in per capita generation of waste

- Type two development work involves program development. In the case of Effect A-7 of the Model, the development of a long term habitat strategy, identifying significant habitat in need of protection, is required before this B_2 type measure can be implemented.

A-7	MEASURE
Wildlife habitat is maintained enhanced.	Trend in number/area of sites of significance to wildlife secured through agreement by CWS in relation to ares targetted for protection.

- Development and fine tuning of results measures will be an ongoing and iterative process, as will the collection and interpretation of result measurement information.

RECOMMENDATION 2: **That MIAB be assigned responsibility for collection of results measurement information and be supported by a committee of regional and headquarters Planning Officers.**

This MI&AB led group would have responsibility for completing the development of measures proposed for implementation in 1991 and 1992, and would be available to provide support in other aspects of C&P planning and reporting. Responsibility for coordination of the results measurement process will place an added workload for MIAB, the resource implications of which should be reviewed at a later date.

VII. USE

There are three main uses for result measurement information. These are Management, Reporting and Communication.

- Management: The use of results measurement information by senior managers has been touched upon previously. Result measures provide senior managers with information pertaining to the achievement of desired results. Result measures should be used as a red flag mechanism to identify areas of potential weakness in program delivery or in the strategies selected to deliver a program. This type of review of C&P programs by senior management can best be done as part of the annual strategic planning process, as it will lead to the modification of programs and strategies, or to the re evaluation of the effects desired.

RECOMMENDATION 3: **That the results measurement information be collected, interpreted and assembled into an annual national report for review by the ADM and C&P Management Committee.**

- Reporting: The department is at present in the process of negotiating its Operational Planning Framework (OPF), in the context of the Increased Ministerial Authority and Accountability (IMAA) Memorandum of Understanding with Treasury Board. Reporting on results is a principle central to the IMAA Regime.

- A presentation was made to representatives of Treasury Board, Programs Branch, the Office of the Comptroller General, and Program Evaluation Branch on March 31, 1989, at which time the direction of the C&P Results Measurement exercise was discussed. Treasury Board was impressed by the results orientation approach adopted by C&P in its OPF development efforts, and expressed particular interest in results measures at the environmental improvement level.

RECOMMENDATION 4: **That A* measures at the Environmental Improvement level be provided to Corporate Planning Group to satisfy Treasury Board requirements related to the OPF and IMAA processes.**

- As A* measures are not available for all Environmental Improvement level effects, it will be necessary to include select strategic level measures in order to give appropriate representation to all C&P Programs. MIAB are best positioned to make the final recommendation regarding the result measurement data provided to CPG/Treasury Board, as it should compliment and be consistent with other management information routinely reported.

- Communication: The character of the Canadian populace is changing. They are better educated; they are less trusting of traditional lines of authority; and they demand results. Recent polling information shows that more Canadians than ever before are aware of environmental issues, and that more than ever before Canadians believe that the federal government is doing a poor job of protecting the environment.

  Clearly there is a role for results measurement data in C&P communications products. Results measurement data can be used to demonstrate the effectiveness of C&P in specific program areas.

- **Misuse**

  On a final note, considerable concern was expressed by C&P managers during the results measurement development process concerning the potential for misuse of the information collected. It is to be emphasized that results measures are but one source of management information. To be an effective tool they must be employed in combination with the other reporting and evaluation mechanisms already in place within C&P.

If a program can be thought of in terms of a two dimensional shape with the various components and emphasis of the program making it an irregular figure, then a result measure at best is the length of a straight line across that shape. The more results measures in place, the better will be the description of the shape, but only a very large number of measures will provide a truly accurate picture of the whole. The analogy of the two dimensional shape is a useful one to keep in mind when interpreting results measurement information, or when interpreting any single source of management information.

APPENDIX A

FULL SET OF RESULTS MEASURES

FOR THE C&P RESULTS MODEL

APPENDIX A

- The full set of results measures as developed for the C&P Results Model is provided. More detailed definition of the measures, along with a discussion of information sources and costs is provided in Volume II - Results Measurement Feasibility Analysis.

- Results Measures are classified as A*, A, B_1 and B_2. Classification pertains to the recommended implementation schedule.

CLASSIFICATION	DESCRIPTION	NO. OF MEASURES
A*	Could be implemented immediately with little or no additional costs and are a key measure.	= 26
A	Could be implemented immediately with little or no additional costs.	= 6
B_1	Require some development work and could be implemented within approximately one year.	= 17
B_2	Require considerable development and are unlikely to be implemented for at least two years.	= 26
	TOTAL	75

1.1 Migratory Birds Conservation

EFFECT	A	B1	B2
ENVIRONMENTAL ENHANCEMENT A1 Migratory Bird Populations are Sustained or Increased	Trend in the breeding populations of ducks in North America. *Trend in populations of mallards in prairie Canada. *Trend in selected population of black ducks in Eastern Canada.	Trend in populations of geese/swans in Western and Northern Canada.	Trend in the breeding populations of non-game birds.
ENFORCEMENT A2 Canadians comply with legislation affecting migratory bird management			(SIGNIFICANT RESOURCES) Trend in the level of compliance with regulations administered by C&P - infractions as a percent of total inspections. Infractions as a percent of total inspections for selected regions (eg. hunting without permit, hunting out of season). Number of warnings/prosecutions as a percent of (i) inspections (ii) investigations.
A3 Canadians implement cooperative programs with C&P to increase enjoyment of migratory birds	*Trend in expenditure of other government agencies and environmental groups on migratory bird-related activities carried out in cooperation with DOE (CWS) Trend in the number of volunteers involved with ongoing cooperative CWS programs/activities and the level of volunteer participation in special (short-term) cooperative CWS programs/activities.		
INFLUENCE A4 Provinces/USA accept harvest limits for game birds	*Trend in percentage of annual hunting regulations guidelines accepted or agreed to by each province; and percentage of recommendations on annual hunting regulations implemented in U.S.		The ratio of harvest rate to recruitement rate for selected wildlife species based on compatability with population management goals: - mallards/pintails in prairie Canada; - Black Ducks in eastern Canada; - Other.

1.2 Wildlife Habitat Enhancement

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT A7 Wildlife habitat is maintained or enhanced	*Trend in the amount of wildlife habitat secured, enhanced or maintained (acquisition/lease/ agreements).		Trend in number/area of sites of signficance to wildlife secured through agreement by CWS in relation areas targetted for protection.
ENFORCEMENT A8 Federal, Provincial and private land managers comply with legislation to protect wildlife habitat			(SIGNIFICANT RESOURCES) Trend in the level of compliance with regulations administered by C&P. Specifically, as per the Migratory Birds Convention Act and Canada Wildlife Act, regulations for National Wildlife Areas and Migratory Birds Sanctuaries.
INFLUENCE A9 Canadians actively support wildlife habitat management, enhancement, and maintenance	Trend in the level of support for wildlife habitat conservation: - number of stamps and prints sold; - revenue for same. *Trend in expenditure of other government agencies and environmental groups on wildlife habitat initiatives carried out in cooperation with DOE (CWS) (Constant Dollars) - other gov't. agencies; - provincial agencies; - NGOs.		
INFLUENCE A10 Land Managers Incorporate Wildlife Habitat concerns into their Land and Aquatic Environmental Management Practices	*Example of success stories involving the incorporation of wildlife concerns into decisions/practices of land and aquatic managers as well as problem areas/missed opportunities.		

1.3 Endangered Species Protection

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT A13 Endangered Species are Reestablished and Rehabilitated	*Trend in the population of selected endangered wildlife species (eg. whooping crane, peregrine falcon, piping plover, burrowing owl, etc.).		
ENFORCEMENT A14 Wildlife Managers and Canadians comply with Legislation to Endangered Species			The trend in the level of compliance with regulations administered by C&F: - number of infractions under AABCA/CWA and WAPPA as a percent of total number of inspections. - number of infractions for selected regs. under WAPPA as a percent of total number of infractions (eg. illegal transportation, CITES permit, violation, etc). - Number of warnings/tickets/ prosecutions as a percent of total number of inspections and investigations.
INFLUENCE A15 Programs are in place to Protect/ Rehabilitate Endangered Species in cooperation with other Stakeholders	*Trend in the percentage of COSEWIC species which have: - a recovery; - a recovery plan being implemented; - a recovery plan completed.		

1.4 International Water & Wildlife Management

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT A18 Canada's Access (Quality/ Quantity) to International Water and Wildlife Resources is Maintained or Enhanced	Trend in the ratio of Canada versus US harvest of selected internationally shared wildlife (eg. ducks, mallards, porcupine caribou, etc). *Trend in population numbers of selected internationally shared wildlife species: - porcupine caribou. *Trend in selected water quality parameters (TDS, pH) toxics in: - Niagara; - Columbia; - St. Lawrence.		
ENFORCEMENT A19 Land Managers comply with legs. related to changes to Canada-U.S River Systems	*Trend in compliance with regulations in international agreements administered by C&P as reported by Regulatory Boards.		
INFLUENCE A20 External Affairs, IJC & other International Fora, incorporate C&P advice on Water/Wildlife	*Assessment of effectiveness of advice/proposals provided to External Affairs, CIDA, and international fora concerning selected major wildlife issues.		
INFLUENCE A21 Agreements for the Management of Canada Internal Water/ Wildlife Resources are in place	*Trend in the percentage of significant international wildlife species covered by agreements/ arrangements (including habitat).	The percentage of significant drainage basins (international) for which management plans are in place.	

1.5 National/Regional Water & Wildlife Management

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT A24 Regional Access to Good Quality Water and Wildlife Resources is maintained or improved	The trend in the proportion of migratory birds and other trans-boundary wildlife harvested by selected regions of Canada. Trend in the population numbers of selected species of transboundary wildlife: - Beverly & Kaminariak caribou. *Trend in the percentage of Canadians participating in, and the level of direct benefits received from wildlife related activities: - primary non-consumptive trips for each province/ territory.	Trend in selected water quality parameters (TDS, pH, toxics) in the Mackenzie, Saskatchewan, Ottawa and Peace-Athabaskin River Basins.	Trend in the population numbers of selected species of transboundary wildlife: - Polar Bears.
INFLUENCE A25 Agreements on the Management of shared (inter-prov./ territorial) Water and Wildlife Resources are in place	*Total number of Co-operative Wildlife Management Agreements under native land claim settlements as a percentage of those sought.		Trend in the number of interprovincial/territorial agreements negotiated with equitable rights to water use.
INFLUENCE A26 Water & Wild-life Mgt. Plans for major drainage basins and regions are in place			The percent of significant river basins (inter-provincial) for which federal-provincial arrangements are in place.

1.6 Natural Hazards Reduction

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT A29 Damages resulting from Natural Hazards are reduced	*Trend in the amount of prevention payments and compensation for crop damage caused by migratory birds and the amount of compensation paid for each prairie province. *Trend in federal disaster assistance payments made for flood damage.		
INFLUENCE Flood Plain Residents are protected from major flooding events		Hydrometric stations having real-time data as a percentage of those designated as requiring real-time data.	Periodic survey of provincial clients to determine satisfaction as to the effectiveness of data provided.
INFLUENCE A31 Land managers implement land use practices designed to reduce damages caused by floods and migratory birds		The trends in the number of farmers using land management practices designed to reduce damages caused by migratory birds.	Percentage of significant flood plain land covered under FDR agreements that have been designated. Percentage of land under FDR for which zoning prevents development.

2.0 ENVIRONMENT - ECONOMY MANAGEMENT

2.1 Management & Administrative Support

2.2 Ecological and Economic Integration

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT B1 Conservation, Development and Protection Efforts combine to produce a healthy Canadian eco-system and economy	*Success stories *Trend in the dollar value and number of jobs to the Canadian economy by wildlife related activities: - gross domestic product; - number of jobs; - personal income; - gov't. revenue generated		
INFLUENCE B5 Environmental and resource value/pricing considerations are integrated into economic planning and decision making		Trend in the per capita generation of waste.	Trend in the growth of the environmental sector.
B6 C&P Environmental Science/ Research is internationally			The amount of success C&P science/research has been internationally recognised.
INFLUENCE B2 C&P Programs are managed effectively and efficiently	*The ratio of resources expended on "overhead" compared to total resources. *The trend in the percentage of C&P goals which were achieved within the planned time-frame and costs.	The trend in external resources supporting C&P objectives.	
B3 C&P programs and policies are developed to respond to new environmental issues and opportu-		Degree to which senior managers respond to new issues and opportunities.	

3.1 Environmental Impact Reduction

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT C1 Adverse Environmental impacts of new initiatives are reduced			(SIGNIFICANT RESOURCES) The potential environmental impact of new initiatives which is avoided through the use of mitigative measures.
INFLUENCE C2 Proponents incorporate C&P advice into development initiatives	*The trend in the level of C&P advice/requirements incorporated into federal initiatives.		
SCIENCE/ DATA C4 Guidelines for environmental assessment are developed		(SIGNIFICANT RESOURCES) The trend in the percentage of major new initiatives for which generic codes and guidelines are available.	

3.2 Air and Water Emissions/Effluents Control

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT C6 Impacts of harmful air & water emissions effluents are reduced	*The trends in level of selected parameters in air, (sulphur dioxide, nitrogen dioxide, carbon monoxide ozone, suspended particulate, etc.)		(SIGNIFICANT RESOURCES) Trend in levels of selected parameters in water.
ENFORCEMENT C7 Polluters comply with legislation related to emissions and effluents	*The trend in the level of compliance with regulation administered by C&P - FA regs.		The trend in the level of compliance with regulation administered by C&P - CEPA regs.
INFLUENCE C8 Environmental quality objectives or guidelines are developed and implemented		The trend in the percentage of emissions/effluent reduction targets established through agreements which are met within planned timeframes. The trend in the level of acceptance and incorporation of C&P guidelines, codes and technical recommendation by client groups.	

3.3 Toxic Chemicals Management

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT C12 Harmful impacts of toxics and other products are controlled			(SIGNIFICANT RESOURCES) The trends in levels of selected parameters in air, water, wildlife, fish and other media.
			Assessment of effects of toxics substances on health of wildlife: - population status; - reproductive performance; - bird defects; - mortality and sublethal effects.
ENFORCEMENT C13 Users comply with legislation on the introduction, use, transportation and disposal of toxics and other products	*The trend in the level of compliance with regulations administered by C&P - lead in gasoline.		The trend in the level of compliance with regulations administered by C&P - CEPA regulations.
INFLUENCE C14 Codes/Guidelines for Lifecycle Management of Chemicals are Developed and Implemented		The trend in the percentage of C&P recommendations implemented by regulatory and line agencies.	Trend in private sector expenditure on toxic control, toxic research and toxic substitutions. The trends in the level of acceptance and incorporation of C&P guidelines, codes and technical recommendations related to lifecycle management of chemicals.

3.4 Spills & Waste Sites Clean-up

EFFECT	A	B1	B2
ENVIRONMENTAL IMPROVEMENT C17 Environmental Quality at spill and waste sites is restored to acceptable levels		The trend in the percentage of major problem waste sites cleaned-up to acceptable levels. The trend in the percentage of spills/environmental emergencies cleaned-up to acceptable levels.	Qualitative assessment of the impacts of spills on wildlife (seabirds/waterfowl) and wildlife habitat.
ENFORCEMENT C18 Polluters comply with legislation on the clean-up of spills/waste sites			Trend in the level of compliance with regulation administered by C&P.
INFLUENCE C19 Contingency plans and other mechanisms exist for dealing with environmental pollution emergencies		The trend in the percentage of spills for which contingency plans were available and implemented.	
Communications (SIGNIFICANT RESOURCES)		Survey of public and special interests to determine awareness, understanding, attitude and behavioural change.	
Science/Data (SIGNIFICANT RESOURCES)		Self assessment relative to knowledge and expertise needs of the C&P science mission.	

APPENDIX B

PROPOSED C&P MANAGEMENT
INFORMATION COMMITTEE/TERMS OF REFERENCE

APPENDIX B

- It is recommended that the Results Measurement Working Group be replaced by a committee of Planning Officers, and that this new committee entitled Management Information Committee assume responsibility for implementing results measures as well as provide broader support on an ongoing basis to Management Information and Accountability Branch in matters relating to C&P planning and reporting.

C&P MANAGEMENT INFORMATION COMMITTEE TERMS OF REFERENCE

Purpose:

To provide a forum for discussing, analysing and developing solutions and recommendations related to the implementation of results measurements, refinement of the Results Definition Model and for improvements in the planning and reporting process.

Responsibilities:

- To determine the feasibility (including costs), and provide recommendations for implementing those results measurements identified for future implementation by the Working Group.

- To develop results measurements as necessary.

- To develop a schedule for future implementation of results measurement.

- To develop a system that will ensure consistency in data collection, interpretation and delivery.

- To monitor the implementation of results measurements.

- To provide recommendations for refining and updating the C&P Results Definition Model.

- To provide recommendations for improvements in the planning and reporting process (i.e., Operation Plans, Work Plans, Minister's Calendar, Weekly Report, mid-year and year end reports).

Composition and Reporting:

The Management Information Committee will consist of one person responsible for planning from each of the Headquarters Directorates, on person from each of the C&P Regions, one person from Finance and Administration and at least one person from Management Information and Accountability Branch.

The Committee will report to the Results Measurement Steering Committee on matters relating to results measurement during the first year of the Results Measurement process, and to the Director, Management Information and Accountability Branch on issues related to the C&P planning and reporting process. Following the initial year of C&P results measurement the Results Measurement Steering Committee will be dissolved and the Management Information Committee will report to the Director, Management Information and Accountability Branch.

APPENDIX C

A FRAMEWORK FOR MEASURING COMMUNICATION RESULTS

APPENDIX C

- An investigation of polling as a tool for measuring results at the Communications level of the Results Model was performed under contract by Synergistics Consulting Limited.

- A select number of current C&P Communications Plans were discussed with the consultant, and example measures developed for each (Example measures to be included in the final report).

synergistics

A Framework for Measuring Communication Results

Prepared for:

Results Measurement Working Group
Environment Canada

September 13, 1989

Synergistics Consulting Limited
TORONTO • OTTAWA • VANCOUVER

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Toronto, Ontario M5A 2W4

Introduction

This paper provides a practical framework within which the impacts of communication programs can be assessed. It is intended to assist the Results Measurement Working Group of Environment Canada in extending their work to include the Department's communication function. After Working Group review, this framework will be used by the consultant to develop specific performance measures for some of the major C & P communication programs and to outline a methodology for data collection.

As with the other functions being evaluated by the Working Group, the results of a communication program must be measured in terms of what it sets out to accomplish, with whom, how, and by when. Hence, the communication objectives, the audience, the communication approach and mechanisms, and the timeframe are all essential inputs into a full evaluation.

A full evaluation involves both a process evaluation and an impact evaluation. A process evaluation addresses the question of how well the program was designed and implemented; an impact evaluation looks only at the program's bottom line results. Given the specific focus of the Department's Results Measurement Action Plan, the communication approach and mechanisms, and other aspects related to process evaluation, will not be dealt with in this paper.

Communications Objectives

The place to start in developing performance measures for a given program is with its objectives. Communication objectives can range from the usual kind of corporate communications objectives; such as, raising awareness of a new initiative, showing leadership, or building support for a point of view; to more substantial program-related objectives like knowledge transfer, consensus building, and behaviour change. Here are some representative examples of possible communication objectives:

Generic Communication Objectives

Awareness	Raising the profile of an issue like global warming, an individual initiative like the St. Lawrence clean-up, or the overall leadership role of an agency like Environment Canada.
Concern	Raising the concern of audiences about an issue like ground water pollution; not fueling the uninformed concern of audiences about non-issues like today's aerosol sprays; demonstrating the concern of the Department about a problem like poor markets for recycled materials.

Attitude	Changing attitudes that impede environmental progress such as those which result in corporate decision-makers waiting until regulations are in place to act; instilling positive attitudes conducive to progress such as "the individual can make a significant contribution to environmental protection".
Perception	Changing an audience's perception of their responsibilities related to the environment; re-allocating Canadians' perceptions of the relative responsibilities of federal and provincial levels of government to be more in keeping with constitutional realities; improving the perceived performance of the Department.
Knowledge	Transferring technical information on specific subjects to specific audiences, such as tertiary sewage treatment systems to municipal engineers; increasing knowledge levels in the general public about things like forest ecosystems.
Understanding	Building understanding of key linkages, such as between improved water quality and increased user fees; transferring a systemic understanding to audiences like commercial fishermen of the interrelationship between the factors producing fish stock declines.
Consensus	Building consensus among different national stakeholders about the approach to different issues, such as the most logical and fair basis for selecting sites for mobile PCB incinerators.
Behaviour	Supporting the interest of Canadians to change their purchase decisions to be more environmentally friendly by providing detailed consumer information; marketing other changes in behaviour (e.g., participation in recycling, water conservation) to establish new norms.

Communication Audiences

Communication audiences are often not defined with enough precision or sophistication. They can range from "micro-audiences" (e.g., federal MP's, residents of one community, frequent users of parks), through specific sectors (e.g., the media, the pulp and paper industry, non-governmental organizations) to general audiences (e.g., corporate decision-makers, opinion leaders, the general public).

In more sophisticated programs, audiences can be defined more in terms of their readiness to adopt the message or behaviour being promoted. Social scientists have shown that change messages move through audiences and society in predictable ways and that the overall process is best described by an S-shaped adoption curve. According to this model, change starts slowly, with the "Pioneers" or "Innovators", those who try on new patterns of thinking and behaviour first. The opinions and activities of these Pioneers are then legitimized by "Early Adopters" and carried to the "Early Majority" audience. This is the exponential curve section of the S-curve, where the particular message or innovation can get catapulted into the main stream views of the audience. This early

majority audience is then followed by the "Late Majority" and finally the "Laggard" category. By targeting messages and choosing communication mechanisms appropriate to each of these audience stages, ambitious results can be achieved.

Performance Measures

Depending on the combination of objectives and audience in a given communication program, an appropriate set of performance measures can be developed and a methodology designed for gauging impact.

Generic kinds of performance measures include:

- Levels of awareness among target audiences before and after the communications;
- Changes in strength of concerns, attitudes and perceptions of issues and actors;
- Extent to which knowledge/understanding was successfully transferred;
- Ability to produce a formal consensus statement at the end of a consultation process;
- Changes in levels of self-reported behaviour;
- Independent/objective measures of behaviour change (e.g., tonnes of paper recycled, sales volumes of environmental friendly products by category).

Evaluation Methods

The methodologies and tools used to measure communication results depend on the objective/audience mix and the performance measures chosen, as well as on budget and time constraints. Here is an array of possible tools from which program-specific choices can be made:

Common Methodologies

Informal Methods	Subjective tools such as number and tone of letters/calls from audience, amount and tone of media coverage, or sometimes simply the lack of negative press, can be sufficient assessments of modest initiatives aimed at raising awareness or concerns.

Key Informants	Semi-structured telephone or in-person interviews by experienced researchers with key opinion-leaders, gate-keepers and other contacts in target audience are cost-effective in producing a semi-quantitative assessment of programs aimed at micro- or sectoral audiences.
Focus Groups	Structured group discussions with 8 to 12 representatives of target audiences, lead by experienced focus group facilitators at locations across the country, can be used as a low-cost way of qualitatively assessing awareness and even knowledge change programs aimed at the general public.
Questionnaires	Mail-out or telephone questionnaires to representatives of micro- or sectoral audiences, if completed in significant volumes, can produce reliable quantitative evaluations of programs with a full range of objectives. When done as part of an iterative Delphi process, questionnaires can even help generate consensus.
Media Analysis	On-going volumetric, content and source analysis of monthly media coverage, conducted by experienced researchers, can provide a reliable trend context within which to quantitatively evaluate programs aimed at opinion-leaders, the general public or the media itself, dealing with awareness, concern and perception changes.
Public Opinion Surveys	Public opinion surveys are the ultimate quantitative tools for evaluating communication programs aimed at the general public, as long as historical or baseline data are available or put in place to allow for pre- and post-program comparison.

It should be stated that significant and sustained communication effort is required to make measurable changes in most of the above performance measures. Hence, if a significant effort is not able to be mounted in a particular case, evaluation should be limited to informal techniques.

The Use of Survey Research

Given the macro/quantitative objectives and requirements of the Results Measurement Action Plan, the only evaluation methodologies on the above list that are appropriate for consideration in the present instance are "questionnaires" and "public opinion surveys".

Given the significant expense of custom survey research, as many needs as possible should be met using the subscription and omnibus research services currently available to the Department, and as many other needs as possible should be met through cooperative ventures to minimize costs.

The subscription, omnibus and co-op research **options** currently available for consideration include the following:

- Influencing the design of core questions on The Environmental Monitor's quarterly surveys, the Decima Quarterly's Summer surveys on environment, or Focus Canada's annual in-depth report on environment to provide tracking questions appropriate to the results measurement needs for certain communication programs. [Cost: none]

- Influencing the analytical categories in the Department's Media Monitoring service. [Cost: none]

- Placing add-on omnibus questions on appropriate surveys of the above three subscription research services. [Cost: $1,400 to $2,000 per question]

- Co-sponsoring and adding questions to a Corporate Planning Group-proposed survey of corporate executives on sustainable development and related issues. [Cost: $10,000 to $20,000 for share in survey]

Once the possibilities inherent in these options are exhausted, survey research tools for evaluating communication programs become somewhat more expensive [i.e., between $50,000 and $100,000 a survey].

APPENDIX D

EXCERPT FROM OCG DOCUMENT:

EVALUATION OF MISSION-ORIENTED R&D PROGRAMS

APPENDIX D

- Consultation with Science and Data collection managers within C&P indicated general support for the results measurement methodology outlined in the March 1986 discussion paper produced by the Office of the Comptroller General "Evaluation of Research and Development Programs."

- The full report is available from Treasury Board of Canada. The section dealing with Mission Oriented R&D Programs is excerpted here.

Chapter 2 EVALUATION ISSUES FOR MISSION-ORIENTED R&D PROGRAMS

The mission-oriented R&D program evaluation issues are regrouped into five main categories: program rationale, client relevance, program management, program outcomes and alternatives. Each of these categories is reviewed in this chapter, and approaches to addressing the issues discussed. Table 2.1 lists the issues that are covered. They should be viewed as illustrative rather than exhaustive.

2.1 PROGRAM RATIONALE ISSUES

Three kinds of program rationale issues are discussed covering program legitimacy, program relevance and program structure issues.

2.1.1 Program Legitimacy

Basic to the rationale of a program is the question concerning the continued legitimacy of its mandate:

- o Do the research activities undertaken by the R&D program constitute a legitimate role for government at this time?

It is generally accepted that government must, in the national interest, perform certain scientific or technical tasks that must be done which no other organization can or is willing to do. It is therefore appropriate for government to do research which clearly enhances the accomplishment of such tasks. It is in this sense that the Wright Task Force concluded in its report (ref. 29) that it is appropriate for government to support research which improves a government department's or agency's capacity to:

- test or monitor;
- establish codes, standards or regulations;
- maintain data bases;
- operate a national facility, such as a wind tunnel or a particle accelerator;
- address a national or regional problem, such as acid rain;

Table 2.1

EVALUATION ISSUES FOR MISSION-ORIENTED R&D

RATIONALE ISSUES

Legitimacy

- Do the research activities undertaken by the R&D program constitute a legitimate role for the government at this time?

Relevance

- Do the conditions which gave rise to the R&D program still prevail today?
- Are the objectives of the R&D program consistent with the government's current policy priorities and goals?
- Does the R&D program fit into a well-defined innovation process? Are the elements necessary to have the R&D work result in a new, significant and beneficial technology there?
- Does the R&D program fit properly within the overall government programming framework?

Structure

- Is the R&D program design and mix of research activities and outputs such that it is reasonable and probable to expect that substantial benefits will accrue from the program, and that these will lead to the intended program results?
- Does the R&D program have a clearly defined clientele?

CLIENT RELEVANCE ISSUES

- To what extent are the various clients/users satisfied that the program is producing or is likely to produce R&D results which will be useful to them?

PROGRAM MANAGEMENT ISSUES

- Is the R&D program managed in such a way that it is reasonable and probable to expect that substantial benefits will accrue from the program, and that these will lead to the intended program results?
- Is the level and distribution of resources in the R&D program adequate?
- Is the size, structure and organization of the R&D program suitable?
- Is the management style appropriate to the particular R&D environment?
- Has the element of risk been adequately considered in decision-making concerning the program delivery?

OUTCOME ISSUES

Objectives Achievement

- Has the R&D program met its objectives in terms of cost, timeliness and result anticipated?

Impacts and Effects

- What have been and/or are expected to be the broad impacts and effects (both positive and negative) of the R&D program?

Quality of Research

- Is the quality of research done adequate given the purposes of the R&D program?

ALTERNATIVES ISSUES

- Could the R&D activities or projects carried out in-house be more effectively performed outside by means of contracts or contributions?
- Could the contracted-out activities or projects be more effectively performed in-house or by means of contributions?
- Could the R&D supported by a contributions programs be more effectively supported by in-house research or contracted out work?

- carry out federal obligations in areas of national security or under various international agreements;
- provide, in conjunction with universities, a "window" on the international scientific community;
- maintain a national competence in certain key scientific sectors;
- help support the goals of private industry (which are in the national interest) when the risks and expenditures involved with the R&D are too high, or the potential payoff too small or too far down the road to attract private industry; or
- help support the goals of private industry (which are in the national interest) when the industry is too fragmented to undertake the necessary R&D.

Accordingly under these criteria, it is appropriate for government to support research which improves the Canadian Grain Commission's capacity to test grain and Environment Canada's capacity to provide meteorological services.

Of course, what may be seen as legitimate for government to undertake varies over time, and an evaluation can merely question the apparent legitimacy or consistency of certain activities with particular policy objectives or report on the views of, for example, the program's private sector clientele on this matter. Evaluators might demonstrate that there exists a clear link between the program's research activities and one or more of the tasks listed above, and that if the research activities were to stop as a result of a program cut, there would be a significant reduction in government's continued ability to perform the tasks so identified. In this demonstration, evaluators might question experts, or the researchers, research managers, or clients/users of the R&D program. They might perform a file review; look at the Department or Agency Act, other pertinent legislation, Cabinet decisions and memoranda, original planning documents; or they might even interview the policy makers responsible for the program. Evaluators might also ask program managers to suggest other pertinent sources of information.

Research activities which cannot be easily linked to one or more of the tasks listed above might be inappropriate for government and evaluators should then be in a position to so inform the client of the evaluation.

2.1.2 Program Relevance

A number of questions can be raised concerning the continued raison d'être of an R&D program:

- o Do the conditions that gave rise to the program still prevail today?

It could be that the conditions (e.g. an energy crisis) that gave rise to a problem to be addressed by government no longer exist or that R&D elsewhere has obviated the need for the program. It might be necessary in some instances to demonstrate that the policy goals supported by the R&D program are indeed valid, that is, in response to specific socio-economic needs. This is obviously a fundamental requirement for the program to make sense. However, the extent to which it will be necessary in an evaluation to address such a question will very much depend on specific circumstances, and will certainly not be the norm as this would greatly enlarge the scope of most R&D program evaluations. Some policy goals, therefore, will have to be taken as given.

- o Are the objectives of the R&D program consistent with the current government policy priorities and goals?

Government policy priorities change over time, and it could be that the R&D program has not changed with them or that the emphasis of the program (e.g. on basic research) is not consistent with the policy priorities of the day (e.g. a focus on economic growth).

Consider this example. Assume one of the policy goals of the federal government is for Canada to achieve total energy self-sufficiency. Many research programs support this goal. In evaluating these programs a number of questions must be raised in the context of program relevance. First, is this energy self-sufficiency goal still relevant, that is, does it remain, in the face of declining world oil prices, pertinent, valid and significant for Canadians? This is a fundamental but difficult question, and one that would probably not normally be addressed in the

course of an energy R&D program evaluation. In other words, the policy goal of energy self-sufficiency would have to be taken as given. Second, do the conditions that gave rise to the energy research program currently being evaluated still prevail? Are oil reserves still declining? Are world oil prices still rising? Are alternative sources of energy as important? Are conservation measures as critical? Is pollution becoming a more serious issue? Is this kind of research now done elsewhere? The answers to such questions could determine whether the conditions that gave the energy R&D program its raison d'être still prevail, or whether they have been replaced by equally valid but different ones, or whether research elsewhere has obviated the need for the program. Thirdly, can the energy R&D program being evaluated be significant to the attainment of energy self-sufficiency? In this context, is an applied research program on solar energy pertinent today? Is the objective of more efficient solar cells still consistent with the overall goal of energy self-sufficiency? Or have recent developments made solar cells uneconomical, and therefore of little immediate utility to the overall goal of energy self-sufficiency? Is the level of effort such that solar cells could become commercially viable sources of energy in a reasonable timeframe? Is the research oriented towards that goal? Such questions, if answered properly, could determine whether or not the mandate and objectives of a solar energy R&D program are consistent with the policy goal of energy self-sufficiency.

Since mission-oriented R&D is not an end in itself, to be relevant an R&D program must fit into a larger framework:

- o Does the R&D program fit into a well defined innovation process? Are the elements necessary to have the R&D work result in a new, significant and beneficial technology there?

These elements can either be an appropriate S&T infrastructure, the necessary supporting technologies, funding (or access to it), an appropriate base (i.e. established firms, the government), or the necessary "R&D" knowledge. In addition to these elements, there must be a real need for the resulting technology (the "pull" of the market), and

the new technology must be socially acceptable. Finally, the numerous steps between research and the integration of the resulting new technology in the organization for which it was developed (i.e. development, prototyping, assembly, marketing, distribution) should all be planned for, or at least possible at, the research stage. If not, the research might not be relevant.

When assessing the relevance of an R&D program, the evaluator should take a global view of the innovation process (ref. 31). Constructing a model of the innovation process surrounding the R&D program is probably a very good idea. Sometimes (e.g. Telidon), the R&D program might not fit into a well-developed innovation process. In such cases the issue of program relevance must be closely examined.

- o Does the R&D program fit properly within the overall government programming framework?

As described in Chapter 1, there are a number of means by which government can support R&D: in-house work, contract work, subsidies and grants, government purchasing, tax incentives and the provision of facilities. This can lead to "stacking", whereby a given sector of R&D activity benefits from more than one source of encouragement in a way that is not effective. For example, if government is already subsidizing R&D in a given industry through tax credits and contributions (and there is a good uptake for these), how relevant can federal government in-house R&D in support of this same industry be? Evaluators should therefore be aware of the total effort in a given R&D area when evaluating the relevance of a particular R&D program, and situate the program within the overall government context in order to identify duplication of effort.

2.1.3 Program Structure

For an R&D program to effective its internal structure must be sound:

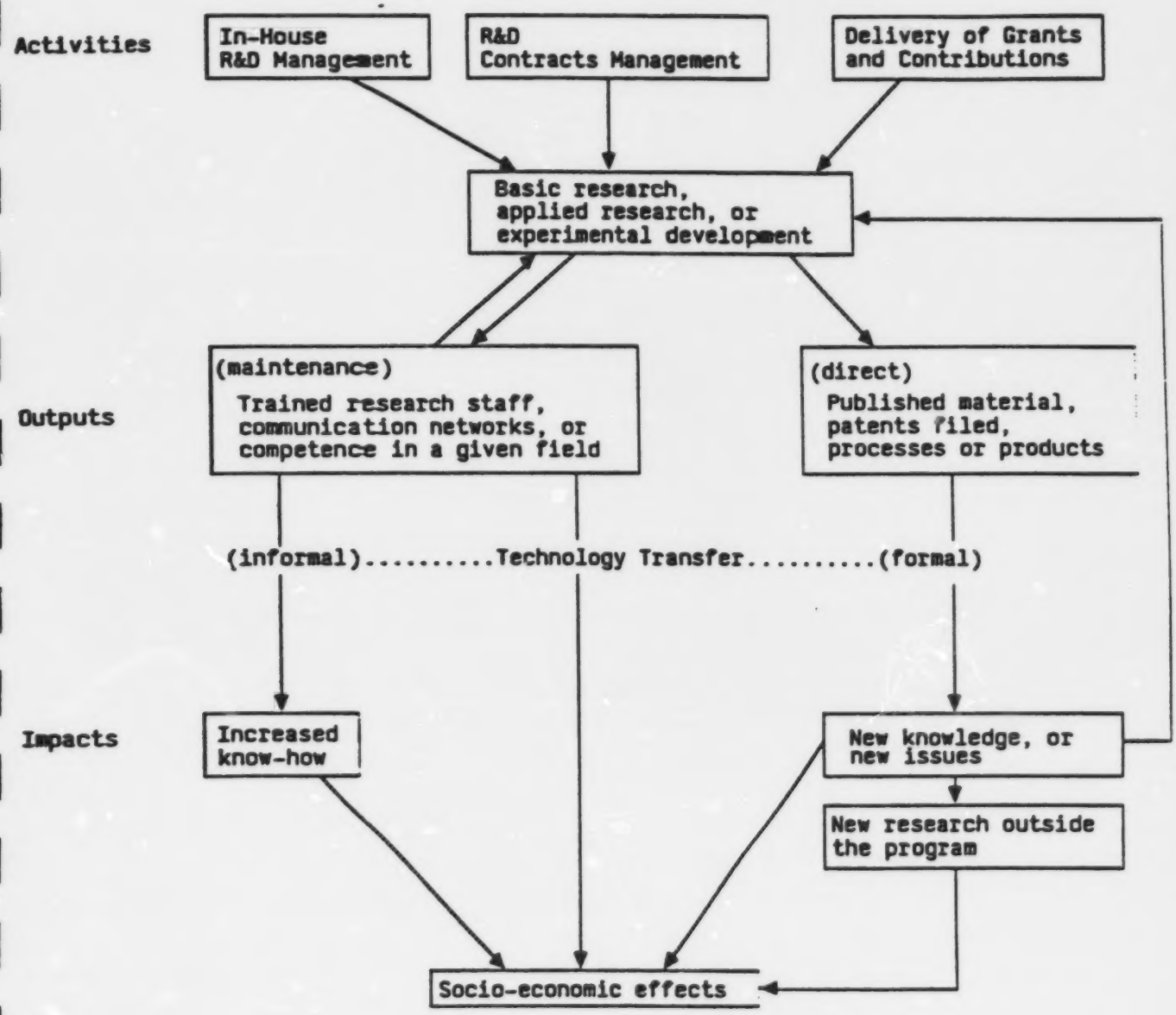
- o Is the R&D program design and mix of research activities such that it is reasonable and probable to expect that substantial benefits will accrue from the program, and that these will lead to the intended program results?

A generic model for R&D programs is given in Figure 2.1. Models can be of valuable assistance in addressing evaluation issues associated with the structure of the program, especially since the activities of an R&D program are not always easily identified. Two main types of R&D outputs are shown: maintenance and direct outputs. Many such programs involve a long-term effort comprising a number of important "maintenance" activities such as network building, support and training, and coordination (ref. 2, 11, 39). These activities lead to "maintenance" outputs, such as communication network, or experienced, knowledgeable staff, as opposed to the more direct outputs such as publications, patents, processes or products which lead to knowledge or new research issues being made known. For a given R&D program, one or both kinds of linkages between outputs and impacts will exist. To properly examine these linkages, and to determine the likelihood of outputs leading to significant impacts and effects, a specific model should be developed for each R&D program being evaluated.

A number of program structure issues can be tackled successfully. A review of the anticipated outputs of the various R&D activities or projects can be done to ensure they are compatible with those of the R&D program as a whole. Gaps between activities or projects and the overall intent of the program can be identified, as well as unnecessary duplication among activities and projects. Duplication and overlap of R&D work between programs or organizations is not necessarily undesirable and should not necessarily be considered negatively. No two research approaches are ever identical (except for verification purposes). Consequently, duplication or overlap might stimulate a sense of competition or of added conscientiousness on the part of the researchers. Outdated activities or projects that have been allowed to continue might also be identified. By regrouping projects by discipline or by theme (e.g. energy-related projects), aggregation of

Figure 2.1

GENERIC MODEL FOR R&D PROGRAMS*



*This generic model excludes general incentives programs and procurement policies in support of R&D in Canada.

projects or of part of projects can be made simpler and more meaningful. It might also be worthwhile to review approval procedures to verify that these are sound and appropriate in ensuring that R&D activities and projects support program objectives achievement.

Even if the R&D program activities or projects can be shown to be likely to lead to significant impacts and effects, these impacts and effects might be different from those envisaged in the program objectives. To return to the previous example, it could be that certain research activities on solar energy cells might be likely to lead to a new cell well suited for space applications. However, such research activities, and their likely impacts, would be outside the scope of an R&D program supporting energy self-sufficiency. In this sense, these activities would not be consistent with program objectives. If the whole research program had that same general orientation, i.e. space applications, then its existence in support of energy self-sufficiency might be questioned.

A final important aspect of program structure for mission-oriented R&D relates to the clientele for the program. Just as the program is to fit into an innovation process, so too is it supposed to have a clientele. Thus an issue is:

- o Does the R&D program have a clearly defined clientele?

This question is important for the reason that technology push (i.e. do research and the applications will take care of themselves) even though it sometimes works, is not believed by policy makers to be generally applicable. Instead, mission-oriented R&D is now thought more likely to yield socio-economic benefits in the presence of strong market pull (i.e. where there are clients able and willing - even eager - to acquire and use the R&D results). Market pull will be strongest where R&D is closely linked to the client. In the case of government in-house R&D programs, this is not always the case. The likelihood of socio-economic benefits being realized will therefore depend, to a large extent, on the degree of client utilization of the R&D results.

Thus if there is not a well-defined client for the R&D program, it is unlikely that the program structure is sound and one might then question the rationale of the program. Indeed, given the importance of the client for mission-oriented R&D, client satisfaction is singled out as a separate evaluation issue.

2.2 RELEVANCE TO THE CLIENT

Mission-oriented R&D is carried out with some outside client in mind, and a deputy is very likely to want to know in these cases if the program is operating in a climate of acceptance by and usefulness to the intended users:

- To what extent are the various clients/users satisfied that the program is producing or is likely to produce R&D results which will be useful to them?

The first step in the evaluation approach suggested here is to identify all the clients of the R&D program. The clients, which in this case will include actual and potential users, may range from university or industrial researchers, who use the publications and reports produced by the R&D program, to senior managers in a department or agency who might use the results of the program to develop new policies. Probably the best way to identify the clientele is to interview program managers and researchers, as well as representatives from various groups or organizations (e.g. companies, universities, or association) in related fields. The second step is to determine to what extent the various clients are satisfied that the program is producing or is likely to produce R&D results which will be useful to them. One way of doing so is to do a survey. However, experience has shown that unless such a survey asks the right questions the survey response will almost always be positive. Whether they are for internal use or for more general consumption, government produced R&D results are usually free. Accordingly, it will be in no one's interest to put their utility in doubt. So what evaluators must do is develop a series of penetrating questions which will force the clients to reveal whether or not the

program's R&D results are or can be of use to them; and if so, why and how. In some instances, such information might already be collected on an on-going basis. If so, evaluators might rely on the information. If not, then such an information system should perhaps be developed to facilitate any subsequent evaluations of the R&D program.

The list of generic questions given below might be a useful guide in developing a specific set of questions to ascertain the true level of utility of the results of the R&D program being evaluated. These generic questions are the result of a review of numerous R&D program evaluation studies. Some apply to private sector clients, other to public sector clients, and many apply to both.

- Has the R&D added to your knowledge of a scientific area or field of application in an incremental or "breakthrough" manner?
- Has the R&D raised important theoretical issues, resolved a scientific controversy, or advanced research techniques?
- Will the R&D enable new lines of research to be explored?
- Has the R&D developed a new generation of highly qualified professionals, contributed to the maintenance of the scientific expertise of older staff; or through staff/student interchanges, has a R&D capability been developed in your organization or anywhere else?
- Has the R&D resulted in products or processes which have led to savings or profits for you?
- Has information resulting from the R&D solved any of your problems, or added to your knowledge of how to apply scientific information to a technical problem?
- Are requests by you for information or assistance related to the R&D increasing or decreasing?
- Has the information resulting from the R&D contributed to the formulation, design, or conduct of other research, or has it been incorporated into government policy or regulations?
- Are the R&D findings potentially relevant to future policy debates or international agreements?
- If the R&D is successful, would the results be applicable or transferable to your operations?

- Are the R&D findings communicated to the general public by means of publications or reports?
- Has the R&D program successfully transferred new technology to the private sector, and has the transfer resulted in new products or processes being marketed nationally or internationally?
- Has the technology transfer had any negative effects?
- Are you actively monitoring the work of the R&D program to seek out commercial opportunities?

It should be noted that the perception and extent of usefulness or potential usefulness of R&D program results might vary considerably as one goes from the top to the bottom of the organization being surveyed. Accordingly, all the relevant management levels of the client organization, from the president to the researcher, should be included in the survey, and each level should be queried as to how they see the R&D results being beneficial to their organization.

The structure of the program's user community is also important to understanding the results of any evaluation based on criteria related to utilization. Thus, for example, the existence of an infrastructure to facilitate utilization (e.g. consortium of private companies, provincial government departments that provide the same service) is an important aspect to consider when evaluating a program (ref. 43).

A related way of determining whether the R&D program has the support of its clientele is to assemble a panel of knowledgeable persons representing the clientele of the R&D program. The panel might then be in a position to give an opinion of just how much the R&D results are or will be useful. This approach might be used to corroborate the client survey findings and possibly reinforce them by adding a qualitative dimension they might otherwise lack.

2.3 PROGRAM MANAGEMENT ISSUES

For many programs, management related issues are not usually directly addressed in a program evaluation. However, management issues can be important in evaluating R&D programs because program outputs and outcomes are directly related to the quality of the work done by researchers and research managers (refs. 14, 16, 18, 39, 51). Thus, a general issue might be:

- o Is the R&D program managed in such a way that it is reasonable and probable to expect that substantial benefits will accrue from the program, and that these will lead to the intended program results?

Given below are three examples which illustrate the importance of management issues for R&D programs.

- o Is the level and distribution of resources in the R&D program adequate?

A proper balance between financial and human resources is very important for the efficient operation research. Proportionally too little financial resources will often result in rundown facilities and equipment. Scientists have a vision of themselves at the cutting edge of their field. This notion is difficult to maintain if their efforts are hindered by antiquated or rundown facilities and equipment. In addition to undermining staff morale, obsolete or rundown facilities and equipment can lead to two outcomes: a wasteful substitution of human resources for equipment and the deterioration of the quality of R&D. Conversely, proportionally too much financial resources will often lead to a large number of contracts. The amount of contract funds that can be efficiently and effectively handled by a research group will depend on the number and complexity of the contracts involved. However, those best equipped to handle the technical side of contracts are often the

scientists themselves, and this will tend to pull them away from their own in-house research work. Furthermore, contract management involves substantially different skills than those needed to do in-house research.

- o Is the size, structure and organization of the R&D program suitable?

The number of scientists and technicians in a research program is another important operational consideration as it has considerable effect on the flow of information. There is a minimum number (or critical mass) for an R&D unit below which there is insufficient information being generated to stimulate the development of new ideas so fundamental to good research. The size of the organization as a whole will also have an influence on communication among researchers. The larger the organization, the less likely researchers will be to know each other. Organizational barriers may occur which impede communication between researchers and senior management, between researchers and clients and between researchers themselves.

- o Is the management style appropriate to the particular R&D environment?

A lot has also been said in recent times about what one U.S. authority has aptly dubbed "micro-management" (ref. 36). This is a condition which most often arises when there is a lack of clearly-defined missions combined with an excess of administration, the two often being complementary. The symptoms are an atmosphere of irrelevance, an overly bureaucratic management style, excessive paperwork and an overall lack of flexibility.

- Has the element of risk been adequately considered in decision-making concerning the program delivery?

R&D projects by definition entail risk and some will and should be expected to not succeed. Decisions concerning individual projects should take this risk into account, particularly in relation to the portfolio of projects being managed. An evaluation might examine how or if the issue of risk is handled in the management of the R&D program. What mechanisms or decision-criteria are in place to terminate or continue projects? On the other hand, it would not normally be productive for an evaluation to assess in hindsight previous judgements on individual projects.

A good indicator of whether management issues are relevant is whether or not they seem to affect the overall effectiveness of the R&D program being evaluated. When it is observed, for example, that an improper balance of resources appears to significantly reduce the overall quality of R&D, then this improper balance might be an issue worth addressing. If it only appears to be an irritant, it is not an evaluation issue. When "micro-management" seems to be reducing morale to the point of affecting overall R&D quality, then it is an evaluation issue. When organizational factors such as size and structure appear to make communication difficult to the point of hindering the diffusion of R&D results or the transfer of technology, or of affecting the responsiveness of the R&D program to its clients, then it is an evaluation issue.

When a management issue is identified as an evaluation issue, a number of possibilities arise. Evaluators can compare (if this is possible) the management situation being considered for possible further evaluation with the management arrangements of other R&D programs. It could well be that the problem is a general one and outside the purview of evaluation. Questions of resources might fall into this category. Evaluators can also verify if other reviews have been done of the

management issue under consideration. If so, what the conclusions of the review were and what has happened since might be very pertinent. Finally, evaluators have to decide whether the issue will be tackled by them, referred to other review groups in the organization, or simply raised for the consideration of senior management.

2.4 PROGRAM OUTCOME ISSUES

The program outcome issues cover questions objectives achievement impacts and effects of the R&D program and the quality of research being done.

2.3.1 Objectives Achievement

- Has the R&D program met its objectives in terms of cost, timeliness and results anticipated?

The objectives of R&D programs should in principle be clearly stated; however, because research is an uncertain activity this is often difficult. With research, the cost of the activity or project, its duration and the results cannot all be specified at the outset. Indeed, if this were not so, research would no longer be research. Furthermore, many important "maintenance" objectives, referred to earlier, such as highly qualified researchers, a communication network or a competence in a given field are often not stated explicitly. Finally, many R&D programs span extended timeframes where results and achievements are characterized by long indefinite time lags. However, such difficulties are not unique to R&D programs, and do not necessarily represent an insurmountable problem. It can be made clear, for example, whether the R&D program supports the formulation of regulations or policy, the mission of the department, industry or science in general. One can also look for a set of appropriate milestones for the R&D program to reach its general objectives. By comparing the R&D program outputs to these milestones, useful and timely information can be obtained for the deputy head. However, R&D program outputs themselves are not aways easily measurable making the comparison between outputs and milestones difficult.

One of the reasons why R&D program outputs are not easily measurable is that R&D programs are often project-based. R&D projects are selected and carried out and each project or collection of projects contributes towards achieving an aggregate program objective. However, only a portion of projects will pay off in the manner anticipated. Others will pay off in unexpected directions by uncovering new opportunities, and some will fail but uncover new, unexpected problems during their execution. In the larger context, a failure may be beneficial in that it might allow management to quickly terminate or redirect research work which had little chance of success. It is, therefore, the aggregate of the project outputs and its overall contribution to program output which must be considered. But, because of the relatively small scale of each project, aggregation into a meaningful output is often difficult unless an appropriate mechanism has been put in place to do so.

2.3.2 Impacts and Effects

- What have been and/or are expected to be the broad impacts and effects (both positive and negative) of the R&D program?

Approaches to measure the impacts and effects of R&D program outputs are also fraught with difficulties (refs. 6, 12, 25, 27, 38, 41, 48). First, long time lags often exist between R&D outputs and the actual acceptance and use of any resulting technology. By their very nature research activities are not repetitive; and by the time an R&D program outcome can be properly assessed, the program has usually moved on to new research. Second, R&D work usually contributes only a small part of the total effort required to see new knowledge, or a new product or process fully developed and internalized in the marketplace or organization for which it was developed (ref. 31). A number of external factors can intervene to diminish the potential impacts and effects of good research. And third, there are many examples where the major R&D outcomes were completely outside those anticipated. The whole field of radio astronomy, which developed out of research done to eliminate background static noise picked up by antennas, is a case in point.

There are two ways to comment on the broad impacts and effects of an R&D program. The first way is to assess the impacts and effects of past research activities and projects. Many years might be needed for the full impacts and effects of research to materialize so that in effect such an assessment reflects upon the R&D program as it was and not as it is now. This is still useful provided one can conclude that past performance is a good indicator of current performance. Whether this can be done in a credible fashion will vary from case to case. The second way to comment on the broad impacts and effects of an R&D program is to consider current research activities and projects and to forecast what their impacts and effects will be. This is obviously very difficult to do but is done all the time by the program's senior management when they select new research avenues. What evaluators can do is to track various research activities and projects, in order to assess whether or not the probability of achieving the intended impacts and effects of the R&D program is being enhanced by these activities and projects. The initial forecast is the responsibility of senior management, but as the research activities and projects progress and time goes on, it is possible to determine whether the intended impacts and effects are more likely to be met or not.

2.3.3 Quality of Research

- Is the quality of research done adequate given the purposes of the R&D program?

Quality of research, while necessary, is not a sufficient condition for program effectiveness, and quality research must today be pursued in the context of a clearly defined purpose. Quality of research is not an outcome in itself. It is a requirement for the R&D program to be effective. But to be effective an R&D program may not need the highest quality of research - the Cadillac model. Too often in the past only the best research possible would do. Maintaining this attitude today would be to ignore the realities of public scrutiny and economic restraint.

In determining the quality of the research produced, the evaluator faces a number of possible approaches, all of which have been tried with more or less success. They are:

- Evaluating by means of peer review the contribution the R&D program is making to scientific or technical knowledge.
- Counting the number of publications associated with the program which have been accepted in refereed journals or conference proceedings.
- Counting the number of citations made of research work undertaken by the program.
- Counting the number of awards or honours the program's laboratory or its professional staff received.
- Counting the number of technical reports produced by the program.
- Counting the number of patents filed or disclosed by the program.

These approaches are described below along with a brief discussion of their respective advantages and disadvantages. In one way or another they all address the question - Is the R&D program producing quality research?

2.3.3.1 Peer Review

Peer review has been considered to be a valuable method in evaluating the quality of research. (ref. 3, 46) It is a basic part of the Natural Sciences and Engineering Research Council's granting process where it is well respected and highly regarded. And the National Research Council has used a well-developed peer review committee system to assess the quality and promise of its research and service activities over more than a decade. However, there are some obvious problems with peer review, (ref. 23). Some of these are:

- identifying knowledgeable peers who are willing to act as reviewers;

- making sure that the selected peers have no conflict of interest; (e.g. receive grants from the program, co-author papers with R&D program professionals or have interpersonal relationships with them);
- presenting information to the reviewers in such a way that inter-rater agreement is high; or differences can be readily understood;
- developing a suitable rating instrument; and,
- ensuring confidentiality.

A multi-criteria approach to peer evaluation appears to be the route taken by several studies. Some of the factors which could be used by a peer to rate published articles or reports are:

- overall research quality;
- raising of important theoretical issues;
- contribution of an important method;
- resolving a recognized controversy;
- contribution of important data;
- leading the field in an appropriate direction; and,
- provision of new ideas for other investigators.

Peer review committees are usually inexpensive, the services of the committee members often being free. They should certainly be considered when measuring the quality of R&D, but only in conjunction with some other methods such as the number of publications, citations, etc. The National Science Foundation of the U.S.A. defended with success in front of Congress the peer review system for the evaluation of research and development.

2.3.3.2 Number of Publications

One common technique for judging the performance of an R&D program is to simply count the number of papers produced during the life of the program or during some given period (ref. 24, 32, 52). While a relatively easy procedure, if used by itself it has some important drawbacks which reduce its effectiveness as a valid technique.

Some of the most important drawbacks are:

- the "counts" do not usually take into consideration the rating of the various journals involved;
- the "counts" reflect quantity (which can be artificially increased) more than quality;

- even the "counts" may be misleading due to multiple articles in different journals or conference proceedings about the same work;
- in some disciplines, especially new ones, the communication of scientific or technical information may not be done via journals, articles, etc.; and,
- some employers actively discourage open literature publication for reasons of either commercial or military secrecy.

In one examination of the use of publications as a measurement criteria for the quality of R&D, Frame (ref. 15) considers that before an evaluator can begin to collect and analyze data, he or she must answer a number of fundamental questions:

- What publications are to be included in the evaluation? Only journal articles? Monographs? Research Reports? Conference Proceedings? Some combination of these?
- What data sources should be used? Self-reporting from scientists or engineers? Abstracts or citation indexes, or both? Journals?
- What time period should be examined? What time lags should be used to take into account that time elapses between doing the research work and getting it published?
- Should only publications that are directly associated with the objectives or field of study of the program be included?
- Have the wide variations in publication rates from discipline to discipline been taken into account?
- What control group is most suitable to use for baseline comparisons? Is the data on the control group readily available or does it have to be developed?

Publications as an indicator of performance are only valid in laboratories where one of the objectives is to contribute to scientific knowledge. (ref. 50) In an applied R&D program, criteria which measure the application of science to new products or processes should be more important and more in line with objectives. In the federal government this is not often done because performance is usually measured using publications as an indicator. In many cases the successful application of science would be a more appropriate measure.

The long time delays required for publications and the advent of computer network telecommunication is bound to change the pattern whereby scientific knowledge gets disseminated. With time, publications will probably become less and less important as an indicator of the quality of R&D work.

2.3.3.3 Citation Analysis

A modification of publication counts is the use of citation analysis techniques. (ref. 17, 26) There are also several drawbacks to using citations as a measure of R&D quality. Among the distorting influences affecting the use of citation measures are:

- the inability to cite the output of secret military and commercially proprietary industrial research;
- the reliance upon personal communication, rather than on formal communications channels (e.g. reports or articles) for the exchange and transfer of technical information;
- the repetition of similar articles by the same author(s) to present the same findings;
- the excessive citations of associate investigators (the "I'll cite you and you cite me" routine);
- the differences between fields in their citation behavior and publishing practices;
- the habit of self-citation;
- the fact that only the first author of a multi-author paper is used in the citation system;
- the variations in how much emphasis is devoted to disseminating the research;
- the variation in how extensively the article submitted to a journal is refereed; and,
- the variation in the rating of the journals.

Martin and Irvine (ref. 27) note the following as additional problems in using citation analysis:

- authors with identical names;
- clerical errors in preparing the citation index;
- incomplete coverage of journals;
- "Halo effect" citations (citing a well-known author);
- variation of citation rate of a paper due to either initially unrecognized advances, or integration of the major advance into the pool of common knowledge; and,
- critical citations, that is, citing authors for their poor research or the unreliability of their findings.

Citation measures cannot be employed properly until several years after the publication of research findings because of the substantial time lags involved in publication. This delay is also one factor which has led to the growth of technical reports, the appearance of "shadow" or "gray" literature, and to more reliance on computer communication networks. Because of the time delay, citation measures should only be

applied to longer term R&D programs. Furthermore, the number of citations versus time will also be indicative of the quality of the research being cited. A sharp rate of rise in the number of citations followed by a steady rate of citations being viewed as good, whereas a sharp rise and fall could be viewed with suspicion.

2.3.3.4 Number of Awards and Honours

Another indicator of R&D program performance is the prestige of the R&D program as seen by outside organizations. (ref. 41) A measure of this prestige is the awards which the professional staff receive from their scientific or professional societies. (ref. 45) Some organizations use such factors as staff elected to national academies and staff invited to sit on government committees as indicators of R&D program quality. This evaluation method is basically a form of peer review with the evaluators being drawn from beyond the immediate boundaries of the scientific or technical discipline covered by the R&D program.

Since these indicators are more closely tied to the evaluation of individual scientists or engineers, they can suffer from two problems the "Halo Effect" or the "Matthew Effect" (ref. 28). For example, a group considering a candidate for an award, may consider the past performance of the person or programs, and not necessarily current performance.

These indicators should definitely be used in conjunction with other more direct indicators such as peer reviews or citation analyses.

2.3.3.5 Number of Technical Reports

In organizations where restrictions on publication in the open literature exist, it is felt that the counting of internal technical reports is a suitable substitute. Again, as in the case of publications in the open literature, the number of technical reports is more a measure of quantity than quality of R&D output. Furthermore, emphasis

on only the number of reports in a given time period could encourage the professional to produce several "hack" pieces rather than one solid, high quality report. The breath of the distribution and demand for the report should therefore also be taken into consideration.

2.3.3.6 Number of Patents

Patent counts and patent statistics have also been used as an indicator of research output. However, this measure has many limitations for the measurement of the output of R&D. Inventions may not be reflected in a patent statistic because as Salasin, Hattery, and Ramsay (ref. 43) point out:

- the inventors may perceive the inventions lack commercial application;
- the propensity to patent varies with the ease with which the technical advance can be copied;
- the inventors may believe that there is greater secrecy if a patent is not obtained;
- the rate of change of technology may be so fast that a patent would not provide any economic advantage;
- some inventions are not patentable;
- the inventors may be more concerned with scientific and technical leadership than patent protection;
- the existence of legal factors is seen as blocking the obtainment of a patent; financial consideration may also affect the patent rate;
- patents do not generally reflect the applied research and inventive activity of the federal government where the propensity to patent is much lower.

Some of the problems with patent counts as a measure of R&D output are: quality variations in patents that are not reflected in patent statistics, and patents which pertain primarily to developmental efforts.

Evaluators are encouraged to bear in mind the pros and cons of each approach and to select an overall approach based on multiple lines of evidence which takes the strengths and weaknesses of each approach into account.

The approaches described above only provide evaluators with the means to determine quality of research in qualitative or relative terms. Such approaches do not answer the question of whether or not the quality of the research is appropriate in the context of the R&D program being evaluated. How then are evaluators to address this question? How does one go about establishing whether or not the quality of research is commensurate with the objectives and the goals of the R&D program, and whether or not the extent of the research undertaken is also commensurate with the objectives and the goals of the R&D program?

To answer such questions, evaluators will have to rely on socio-economic analyses in order to determine the potential benefits, relative importance and likelihood of success of the research. This is by no means an easy task. To a large extent these questions cannot be isolated from the issues of program relevance. Some R&D programs are more relevant than others and can justify more or higher quality research or both.

It must be clearly recognized, however, that addressing the issue of the quality of research can only lead to marginal changes (i.e. more or less research, or higher or lower quality research). The significant potential for change lies with an examination of the program legitimacy and relevance issues. Accordingly, only the appropriate amount of "evaluation" resources should be directed to the issue of the quality of research of an R&D program.

2.5 ALTERNATIVES ISSUES

The final group of issues discussed deal with questions of better alternative ways of achieving the intended outcomes of the R&D program. But in most cases an evaluation would not produce a definitive alternative delivery or program design. An evaluation typically would only identify promising program delivery mechanism alternatives which could be further examined by an appropriate planning group. For example,

an evaluation study could indicate that, for a given R&D program, the in-house R&D activities could possibly be contracted-out. In another instance, that in-house R&D could likely be carried out outside government by means of appropriate contributions.

As was seen in the first chapter, there are three ways by which the federal government can support mission oriented research: in-house, contracts, and contributions. Thus the alternatives issue for in-house R&D is:

- o Could the R&D activities or projects carried out in-house be more effectively performed outside by means of contracts or contributions?

for contracted-out R&D:

- o Could the contracted-out activities or projects be more effectively performed in-house or by means of contributions?

and, for R&D supported by contributions:

- o Could the R&D supported by a contributions programs be more effectively supported by in-house research or contracted-out work?

In the federal government, the contracting-out policy for science and technology requirements (ref. 49) encourages departments and agencies to contract out R&D work whenever appropriate, and there are only a specific number of criteria which justify R&D work being done in-house. For example, it could be that the only way for government to really maintain secrecy or neutrality in a given activity or project is to carry out the R&D work in-house. And R&D work should also be done in-house if, in order to properly support federal policy goals, it is necessary for government to:

- develop internal scientific competence;
- maintain continuity in a particular area;
- develop and maintain contacts with the international scientific community;

or if:

- there is a lack of competence or interest outside government; or,
- contracting-out the R&D work would not be cost-effective.

However, whether or not in-house R&D work should be contracted out, evaluators should be aware that some R&D programs were created a long time ago, and that these past decisions have led to a distribution of tasks and responsibilities that might make it more sensible today to accept the presence of in-house research as is. On the other hand, evaluators should also remember that there can be additional benefits when R&D is performed by the private sector, or done in universities.

Finally, whether the research is done by government (i.e. in-house or contracted out) or by the industry (i.e. by means of contributions) is much less operational in nature and involves a number of policy considerations: how capable and willing is the industry, how likely is it that contributions will actually increase the level of R&D in industry, and will the social benefits exceed the costs?